

REMARKS

Applicants thank the Examiner for the interview of January 21, 2004. The substance of the interview is summarized by the remarks below.

Claims 40 and 48 are amended. Support for the amendments can be found, for example, at page 4, line 27 to page 5, line 10 and page 9, line 23 to page 10, line 9, Example 7 on pages 35 – 37, and in Figure 7.

New claims 80 – 84 are added. Support for the new claims can be found, for example, in Example 7 on pages 35 – 37 and in Figure 7.

Claim 80 recites a concentration for the fluorine compound of 2 to 10% by volume. Claims 80, 81, and 83 also recite limitations regarding the nickel content of the catalyst and the decomposition rate of the fluorine compound. Claims 82 and 84 recite a reaction temperature from about 400 °C to about 700°C.

The rejection of claims 40 – 43, 45 – 49, 51, and 79 under 35 USC 103(a) over Rossin et al., US Patent 6,069,291, optionally in view of Okazake et al., US Patent 5,151,263, and optionally in view of Imamura, US Patent 5,649,985 is respectfully traversed. Rossin et al. describes a process for decomposing perfluoroalkanes using a catalyst containing aluminum oxide and another metal oxide stabilizer. The patent is directed to aluminum oxide catalysts that contain a stabilizer, but the data also indicates the conversion percentage of perfluoroalkanes for the catalyst compositions.

Rossin et al. broadly describes a variety of possible aluminum oxide containing catalysts, including the possibility of adding nickel to the catalyst. However, the disclosed examples in Rossin et al. are much narrower. Examples I – XIX of Rossin et al. provide data on the decomposition of perfluoroalkanes when contacting an aluminum oxide catalyst or a catalyst containing aluminum oxide plus a stabilizer selected from the group magnesium oxide, lanthanum oxide, chromium oxide, cobalt oxide, cerium oxide, and zirconium oxide. Additionally, one Example is given of a catalyst containing both cobalt and zirconium. In all but two of the Examples, the amount of the secondary material added to the aluminum oxide is 5% or less. The exceptions are Example XIII, which describes a catalyst containing 50% zirconium oxide, and Examples XVI - XVIII, which provide results for a catalyst containing 3% zirconium oxide and 5% cobalt oxide. Note that no Example is given for a catalyst composition containing nickel oxide.

Rossin et al. provides data on the decomposition rate for catalysts of each of the above types. In the Examples involving catalysts containing 5% or less of a stabilizer, the data provided in Rossin et al. generally shows that the additional stabilizer has little to no effect on reactivity. In the Examples listed in the table below, the decomposition rate of a gas stream containing 500 ppm C₂F₆ at a flow rate of 1800 hr⁻¹ is measured as a function of temperature. Because the Examples do not consistently use the same temperatures, a

quantitative comparison is difficult. However, qualitatively, the Examples in Rossin et al. show the following:

Example	Added Stabilizer	Conversion efficiency relative to aluminum oxide catalyst of Example I
IV	0.85% magnesium	Similar
V	1.0% lanthanum	Similar/Lower
VI	0.8% chromium	Similar
VII/IX	4.0% cobalt (at 1000 ppm C ₂ F ₆)	<cannot compare directly>
X	5.0% cerium	Similar/Lower
XIII	50% zirconium	Lower
XIV	3% zirconium	Similar/Higher
XVII	3% zirconium, 5% cobalt (only data at 700 C)	Similar(?)

Based on the data provided by Rossin et al., one of ordinary skill in the art would understand that addition of 5% or less of a metal oxide does not have a large impact on the decomposition reaction. Adding 3% zirconium results in a somewhat higher decomposition percentage, while adding cerium or lanthanum appears to depress the decomposition rate. However, one of skill in the art would readily observe the large decrease in reactivity for the catalyst containing 50% zirconium.

In addition to the Examples for exposure of a catalyst to C₂F₆ at 500 ppm, Example XIX shows the conversion percentage for the aluminum-zirconium

oxide catalyst of Example XIV (3% zirconium) when exposed to 5000 ppm of CF₄. Comparing the results at 700 C, Example XIV shows a 99.5% conversion while Example XIX shows a 65.8% conversion. The conversion rates of Example XIX are similarly lower than the conversion rates of Example XIV at the other disclosed temperatures. Thus, Rossin et al. teaches that exposing a catalyst to a higher rate flow rate of fluorinated compound also reduces the conversion percentage.

Based on the data presented in Rossin et al., one of skill in the art would not expect that adding 5% or greater of nickel (or another metal) to the aluminum oxide catalyst would result in substantially higher conversion percentages for fluorinated compounds at a given temperature. In general the catalyst compositions in Rossin et al. show a similar or lower conversion percentages relative to an aluminum oxide catalyst. Even though the 3% zirconium catalyst showed an increase in conversion percentage versus a pure aluminum oxide catalyst, the 50% zirconium catalyst showed a noticeably lower conversion percentage for a given temperature. Thus, Rossin et al. further teaches that a stabilizer such as zirconium, which enhances the conversion percentage of fluorinated compounds when present at 3%, significantly lowers the conversion percentage when present in greater amounts. Additionally, based on the data in Rossin et al., one of skill in the art would not expect to be able to maintain high conversion percentages at a constant temperature for flow rates

that are significantly higher than 500 ppm, such as the 5000 ppm from Example XIX.

Applicants have unexpectedly found that catalysts containing aluminum oxide and greater than 5 weight % of nickel oxide show increased decomposition percentages for fluorinated compounds relative to catalysts containing only aluminum oxide. Figure 6 shows the decomposition rate of C₂F₆ gas at 700°C when exposed to an aluminum oxide catalyst (catalyst 19) and nickel-aluminum oxide catalysts containing 12.7 weight % nickel (catalysts 27 and 28). Unlike the catalysts in Rossin et al., the addition of more than 5 weight % of nickel to the catalyst results in a substantial increase in the decomposition rate for a fluorinated compound.

Figure 7 shows the effect of changing the nickel concentration on the decomposition rate. Note that the results in Figure 7 are expressed as mole percent rather than as weight percent. Figure 7 shows that catalysts with added nickel concentrations between 5 mole percent (7.2 weight %) and 30 mole percent (38.6 weight %) show substantially higher decomposition rates than a pure aluminum oxide catalyst.

In addition to unexpectedly showing a higher decomposition rate as compared to an aluminum oxide catalyst, the nickel-aluminum oxide catalysts of the claimed invention also allow for efficient decomposition of high flow rates of fluorinated compounds at lower temperatures. Figure 7 shows the decomposition rate for a flow of 5000 ppm of C₂F₆ at 700°C. The catalysts

having a nickel content between 7.2 weight % and 38.6 weight % show a decomposition rate of greater than 80%, with the decomposition rate being above 95% for catalysts with a nickel content between 26.8 and 38.6 weight %. This is in contrast to Rossin et al., where the decomposition rate for a 5000 ppm flow of CF₄ exposed to the 3% zirconium-aluminum oxide catalyst was only 65.8% at 700°C.

Because of the unexpected catalytic activity of the nickel-aluminum oxide catalysts of the claimed invention relative to the catalysts described in Rossin et al., the method of the claimed invention provides unexpectedly superior decomposition of fluorinated compounds at high flow rates. Thus, claims 40 and 48 are patentable in view of Rossin et al.

In particular, the method of the claimed invention also unexpectedly allows for decomposition of greater than 80% of a fluorinated compound that is delivered at a concentration of about 5000 ppm or greater. As a result, claim 81 is patentable in view of Rossin et al. This decomposition rate can be achieved at a temperature of about 700°C or less. Thus, claim 82 is patentable in view of Rossin et al. Further, the claimed invention unexpectedly allows for decomposition of greater than 95% of a fluorinated compound that is delivered at a concentration of 5000 ppm or greater. As a result, claim 83 is patentable in view of Rossin et al. This decomposition rate can be achieved at a temperature of about 700°C or less. Thus, claim 84 is patentable in view of Rossin et al.

Additionally, the method of the claimed invention is effective for decomposition of gas streams containing between 2 and 10% (20,000 to 100,000 ppm). Rossin et al. provides no examples or suggestion for treating a gas stream containing greater than 5000 ppm. Thus, claim 80 is patentable in view of Rossin et al. For at least the above reasons, reconsideration and withdrawal of the rejection of claims 40 – 43, 45 – 49, 51, and 79 over Rossin et al., optionally in view of Okazaki et al. or Imamura, is respectfully requested.

The rejection of claims 44 and 50 over Rossin et al. in view of Rosenbaum, US Patent 5,460,792, is also respectfully traversed. Rosenbaum discloses a process for the destruction of organic compounds using a carbonaceous catalyst. The catalyst can be supported on alumina. However, Rosenbaum does not disclose or suggest use of nickel-aluminum oxide catalysts as required by the claimed invention. Thus, Rosenbaum also does not address the unexpected improvement in decomposition rates of fluorinated compounds provided by the nickel-aluminum oxide catalysts of the claimed invention. Reconsideration and withdrawal of this rejection are respectfully requested.

In view of the foregoing amendments and remarks, the application is respectfully submitted to be in condition for allowance, and prompt, favorable action thereon is earnestly solicited.

If there are any questions regarding this amendment or the application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

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If necessary to effect a timely response, this paper should be considered as a petition for an Extension of Time sufficient to effect a timely response, and please charge any deficiency in fees or credit any overpayments to Deposit Account No. 05-1323 (Docket #056203.50311).

Respectfully submitted,

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